IN THE CLAIMS

We claim:

1. A method of processing a wafer comprising:

placing a wafer in a single wafer cleaning tool;

spinning said wafer in said single wafer cleaning tool and while spinning said wafer;

after placing said wafer in said single wafer cleaning tool, exposing said wafer to a solution comprising:

NH_4OH;

H_2O_2;

H_2O; and

a chelating agent.

2. The method of claim 1 wherein said wafer is exposed to said cleaning solution for less than 30 seconds.

3. The method of claim 1 wherein said chelating agent is a carboxylic acid.

4. The method of claim 1 further comprising cleaning a front side of said wafer with said cleaning solution while cleaning a back side of said wafer with a solution different from said cleaning solution.

5. The method of claim 1 further comprising applying acoustic waves to said wafer while cleaning said wafer.

6. The method of claim 5 wherein said acoustic waves are megasonic.

7. The method of claim 1 further comprising dissolving a cavitation gas into said cleaning solution.

8. The method of claim 7 wherein said cavitation gas is chosen from the group H_2, N_2, O_2, O_3, Ar, and He.

9. The method of claim 1 further comprising a thermal processing step at a temperature exceeding 400°C after cleaning said wafer.

10. The method of claim 9 wherein said thermal processing step is an anneal step.

11. The method of claim 9 wherein said thermal processing step is a chemical vapor deposition step.

12. The method of claim 9 wherein said thermal processing step is an oxidation step.

13. The method of claim 1 further comprising an O_2 ashing step to remove a photoresist from said wafer before placing said wafer in said single wafer cleaning tool.

14. The method of claim 1 wherein said chelating agent is ethylenediaminetetraacetic acid (EDTA).

15. The method of claim 1 wherein said solution is further comprises a surfactant.

16. The method of claim 15 wherein said surfactant is 1-100ppm of said solution.

17. The method of claim 15 wherein said surfactant is non-ionic.

18. The method of claim 15 wherein said surfactant is anionic.

19. The method of claim 15 wherein said surfactant is a mixture of non-ionic and anionic compounds.

20. The method of claim 17 wherein said non-ionic surfactant is polyoxyethylene butyphenl ether.

21. The method of claim 18 wherein the anionic surfactant is polyoxyethylene alkylphenl sulfate.

22. The method of claim 17 wherein said non-ionic surfactant is 30ppm of said solution.

23. The method of claim 9 wherein said anionic surfactant is 30ppm of said solution.

24. A cleaning solution formed from a mixture comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant.

25. The cleaning solution of claim 24 wherein said NH_4OH, H_2O_2, and H_2O have a mixing ratio of between 5/1/1 and 1000/1/1.

26. The cleaning solution of claim 24 wherein said NH_4OH is from a solution of between 28-29% w/w of NH_3 to water.

27. The cleaning solution of claim 24 wherein said H_2O_2 is from a solution of between 31-32% w/w of H_2O_2 to water.

28. The cleaning solution of claim 24 wherein said chelating agent has an equilibrium constant (K) greater than 10^{15} for aluminum.

29. The cleaning solution of claim 24 wherein said chelating agent has an equilibrium constant (K) greater than 10^{20} for aluminum.

30. The cleaning solution of claim 24 wherein said chelating agent is chosen from the group N,N'-Bis(2-hydroxyphenyl)ethylenediiminodiacetic acid (HPED), triethylenetetranitrilohexaacettic acid (TTHA), desferriferrioxamin B, N,N',N''-Tris[2-(N-hydroxycarbomyl)ethyl]-1,3,5-benzenetricarboxamide (BAMTH), molybdic acid.

31. The cleaning solution of claim 24 wherein said chelating agent has a concentration in said solution between 0.001 mg/l and 300 mg/l.

32. The cleaning solution of claim 24 wherein said chelating agent has a concentration in said solution of between 0.01 mg/l and 3 mg/l.

33. The cleaning solution of claim 24 wherein said chelating agent has a concentration in said solution of between 1-400ppm.

34. The cleaning solution of claim 24 wherein said surfactant is non-ionic.

35. The cleaning solution of claim 24 wherein said surfactant is anionic.

36. The cleaning solution of claim 35 wherein said surfactant is MCX-SD2000 manufactured by Mitsubishi Corporation.

37. The cleaning solution of claim 36 wherein said MCX-SD2000 is 0.05% of said solution.

38. The method of claim 34 wherein said non-ionic surfactant is polyoxyethylene butyphenl ether.

39. The method of claim 35 wherein the anionic surfactant is polyoxyethylene alkylphenl sulfate.

40. The method of claim 34 wherein said non-ionic surfactant is 30ppm of said solution.

41. A method of cleaning a wafer comprising:

etching said wafer with a hydrogen fluoride solution;

after etching said wafer, rinsing said wafer with a first rinse;

after rinsing said wafer with said first rinse, cleaning said wafer with a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant;

after cleaning said wafer with said cleaning solution, rinsing said wafer with a second rinse;

after said rinsing of said wafer with said second rinse, drying said wafer; and wherein said processing is done within 3 minutes.

42. The method of claim 41 wherein said processing is done in less than or equal to two minutes.

43. The method of claim 41 wherein said etching is done within 30 seconds.

44. The method of claim 41 wherein said first rinse is done within 20 seconds.

45. The method of claim 41 wherein said cleaning is done within 30 seconds.

46. The method of claim 41 wherein said second rinse is done within 20 seconds.

47. The method of claim 41 wherein said drying is done within 20 seconds.

48. The method of claim 41 wherein during said etching of said wafer an etching solution is applied to a front side of said wafer and a solution different from said etching solution is applied to a back side of said wafer.

49. The method of claim 41 wherein during said first rinse of said wafer a rinsing solution is applied to a front side of said wafer and a solution different from said rinsing solution is applied to a back side of said wafer.

50. The method of claim 41 wherein during said cleaning of said wafer said cleaning solution is applied to a front side of said wafer and a solution different from said cleaning solution is applied to a back side of said wafer.

51. The method of claim 41 wherein during said second rinse of said wafer a rinsing solution is applied to a front side of said wafer and a solution different from said rinsing solution is applied to a back side of said wafer.

52. A method of forming a rinse comprising:

degassing H_2O; and

dissolving a gaseous oxidant into said H_2O.

53. The method of claim 52 wherein said H_2O is deionized.

54. The method of claim 52 wherein said gaseous oxidant is O_2.

55. The method of claim 52 wherein said gaseous oxidant is O_3.

56. The method of claim 52 wherein said gaseous oxidant is dissolved in said water at point of use.

57. The method of claim 52 wherein said gaseous oxidant is dissolved in said water by a venturi apparatus.

58. The method of claim 52 wherein said gaseous oxidant is dissolved in said water by passing said rinse along a hydrophobic membrane that allows gases through but not said rinse.

59. A method of cleaning a wafer comprising:

cleaning said wafer with a first solution comprising a chelating agent and a surfactant;

after cleaning said wafer, rinsing said wafer with said solution comprising water and an oxidizing agent.

60. The method of claim 59 wherein said oxidizing agent is chosen from the group: O_3, O_2, and H_2O_2.

61. The method of claim 59 wherein said oxidizing agent is present in said second solution in a concentration sufficient to oxidize Cu^{2+}.

62. The method of claim 59 wherein said concentration of said oxidizing agent is greater than 1ppm.

63. The method of claim 59 wherein said concentration of said oxidizing agent is greater than 100ppm.

64. The method of claim 59 wherein said second solution has a standard oxidation potential greater than 0.5V.

65. The method of claim 59 wherein said water is degasified before said oxidizing agent is added to said water.

66. The method of claim 59wherein said water is deionized.

67. A method of processing a wafer comprising:

placing said wafer in a single wafer cleaning tool;

after placing said wafer in said single wafer cleaning tool, dispensing an HF solution on said wafer for between 2-3 seconds to produce an HF covered wafer; and

after dispensing said HF solution on said wafer, dispensing a cleaning solution on said HF covered wafer.

68. The method of claim 67 further comprising spinning said wafer during said processing.

69. The method of claim 67 wherein while said HF solution is dispensed on a first side of said wafer, a solution different from said HF solution is dispensed on a second side of said wafer.

70. The method of claim 67 wherein megasonics are applied to said wafer when said cleaning solution is dispensed on said wafer.

71. The method of claim 67 wherein said wafer has a surface with an oxide layer.

72. The method of claim 71 wherein said hydrofluoric acid solution is dispensed on said surface with said oxide layer.

73. The method of claim 72 wherein said hydrofluoric acid solution etches said oxide layer to a thickness of between 1Å and 8Å.

74. The method of claim 67 wherein said cleaning solution comprises:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant.

75. The method of claim 67 wherein said cleaning solution is on said wafer for less than 30 seconds.

76. The method of claim 67 wherein said cleaning solution is dispensed on said HF covered wafer for a time sufficient to neutralize said HF solution.

77. The method of claim 67 wherein said HF solution comprises water and hydrofluoric acid.

78. The method of claim 67 wherein said HF solution comprises water and buffered hydrofluoric acid.

79. A method of processing a wafer comprising:

placing a wafer having a first side and a second side in a single wafer cleaning tool;

after placing said wafer in said cleaning tool, dispensing an HF solution on said first side of said wafer for 2-3 seconds to produce an HF covered first side of said wafer;

simultaneous to dispensing said HF solution on said first side of said wafer, dispensing a solution different from said HF solution on said second side of said wafer; and

after dispensing said HF solution on said first side of said wafer, dispensing a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant,

on said HF covered first side of said wafer.

80. A method of processing a wafer comprising:

placing a wafer with a first side with a hydrophilic surface and a second side in a single wafer cleaning tool;

after placing said wafer in said single wafer cleaning tool, spinning said wafer;

while spinning said wafer, dispensing an HF solution on said first side of said wafer for a time short enought to leave said hydrophilic surface on said first side of said wafer;

simultaneous to dispensing said HF solution on said first side of said wafer, dispensing a solution different from said HF solution on said second side of said wafer; and

after dispensing said HF solution on said first side of said wafer, dispensing a cleaning solution on said first side of said wafer.

81. The method of claim 80 wherein said cleaning solution comprises:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant.

82. The method of claim 80 wherein said HF solution is dispensed on said wafer for a time sufficient to leave a concentration of less than 5×10^{10} atoms/cm^2 of aluminum on said wafer.

83. A method of processing a wafer comprising:

etching a wafer with an HF solution;

after etching said wafer, cleaning said wafer with a solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and,

a surfactant;

after cleaning said wafer, drying said wafer; and

wherein said processing is done within 3 minutes.

84. A method of processing a wafer comprising:

placing said wafer in a single wafer cleaning tool;

after placing said wafer in said single wafer cleaning tool, spinning said wafer;

while spinning said wafer, dispensing a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant;

on said wafer;

after dispensing said cleaning solution on said wafer, rinsing said wafer with a first rinse;

after rinsing said wafer, dispensing a hydrofluoric acid solution on said wafer for between 2-3 seconds; and

after cleaning said wafer, rinsing said wafer with a second rinse.

85. The method of claim 84 wherein said first rinse and said second rinse are the same solution.

86. A method of processing a wafer comprising:

cleaning said wafer with a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent, and

a surfactant;

after cleaning said wafer, rinsing said wafer with a first rinse;

after rinsing said wafer with said first rinse, etching said wafer with an HF solution;

after etching said wafer, rinsing said wafer with a second rinse; and

wherein said processing is done within 3 minutes.

87. The method of claim 86 wherein said first rinse and said second rinse are the same solution.

88. A method of processing a wafer comprising:

O2 ashing a wafer having a first side and a second side, wherein said O2 ashing is done to said first side of said wafer;

after O_2 ashing said first side of said wafer, cleaning said first side of said wafer with a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent, and

a surfactant; and

after cleaning said wafer, rinsing said wafer with a rinsing solution.

89. The method of claim 88 wherein said wafer is spun during said processing.

90. The method of claim 88 wherein megasonics are applied to said wafer during said processing.

91. The method of claim 88 further comprising rinsing said first side of said wafer before cleaning said first side of said wafer.

92. The method of claim 88 further comprising rinsing said first side of said wafer after cleaning said first side of said wafer.

93. The method of claim 88 wherein said rinsing solution is ozonated water.

94. The method of claim 88 further comprising drying said wafer after cleaning said wafer by spinning said wafer at speeds between 2000-4000 rpm after rinsing said wafer.

95. The method of claim 88 further comprising simultaneous to cleaning said first side of said wafer, cleaning said second side of said wafer with a solution different from said cleaning solution.

96. A method of processing a wafer comprising:

cleaning said wafer with a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant;

after cleaning said wafer, rinsing said wafer;

after rinsing said wafer, drying said wafer; and

wherein said cleaning, rinsing and drying is done within 2 minutes.

97. A method of processing a wafer comprising:

placing a wafer in a single wafer cleaning tool;

after placing said wafer in said single wafer cleaning tool, dispensing an HF solution on said wafer; and

cleaning said wafer with a cleaning solution.

98. The method of claim 97 further comprising spinning said wafer during said processing.

99. The method of claim 97 wherein said cleaning solution comprises:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent; and

a surfactant.

100. A method of cleaning a wafer comprising:

placing a wafer in a single wafer cleaning tool;

after placing said wafer in said single wafer cleaning tool, spinning said wafer;

while spinning said wafer, dispensing an HF solution on said wafer; and

after dispensing said HF solution on said wafer, dispensing a cleaning solution comprising:

NH_4OH;

H_2O_2;

H_2O;

a chelating agent;

a surfactant; and

on said wafer.

101.A cleaning solution comprising:

NH_4OH; and

N,N'-Bis(2-hydroxyphenyl)ethylenediiminodiacetic acid (HPED).

102.A method of cleaning a wafer comprising:

placing said wafer in a single wafer cleaning tool;

cleaning said wafer with a cleaning solution comprising:

NH_4OH; and

N,N'-Bis(2-hydroxyphenyl)ethylenediiminodiacetic acid (HPED).

103.A cleaning solution comprising:

NH_4OH; and

triethylenetetranitrilohexaacettic acid (TTHA).

104.A method of cleaning a wafer comprising:

placing a wafer in a single wafer cleaning tool;

cleaning said wafer with a solution comprising:

NH_4OH; and

triethylenetetranitrilohexaacettic acid (TTHA).

105.A cleaning solution comprising:

NH_4OH; and

desferriferrioxamin B.

106.A method of cleaning a wafer comprising:

placing a wafer in a single wafer cleaning tool;

cleaning said wafer with a solution comprising:

NH_4OH; and

desferriferrioxamin B.

107.A cleaning solution comprising:

NH_4OH; and

N,N′,N″-Tris[2-(N-hydroxycarbomyl)ethyl]-1,3,5-benzenetricarboxamide (BAMTH).

108.A method of cleaning a wafer comprising:

placing a wafer in a single wafer cleaning tool;

cleaning said wafer with a rinsing solution comprising:

NH_4OH; and

N,N′,N″-Tris[2-(N-hydroxycarbomyl)ethyl]-1,3,5-benzenetricarboxamide (BAMTH).

109.The method of claim 108 wherein megasonics are applied to said wafer during said rinsing.

110.The method of claim 108 wherein said rinsing solution is applied to a first side of said wafer and a solution different from said rinsing solution is applied to a second side of said wafer.

111.A cleaning solution comprising:

NH_4OH; and

molybdic acid.

112.A method of cleaning a wafer comprising:

placing a wafer a in single wafer cleaning tool;

cleaning said wafer with a solution comprising:

NH_4OH; and

molybdic acid.

113.A rinse comprising:

H_2O;

CO_2; and

an oxidant.

114.The rinse of claim 113 wherein an said rinse has an amount of CO_2 sufficient to dissipate static electricity in said rinse.

115.The rinse of claim 113 wherein the oxidant is chosen from the group O_2, O_3, and H_2O_2.

116.A method of rinsing a wafer comprising:

placing a wafer in a single wafer cleaning apparatus;

spinning said wafer; and

rinsing said wafer with a solution comprising H_2O and CO_2.

117.The method of claim 112 further comprising dissolving CO_2 into said H_2O by passing said H_2O along a hydrophobic membrane that allows gases through but not said H_2O before rinsing said wafer.

118.A method of dissolving CO_2 gas into H_2O comprising:

using a stacked membrane comprising a solid first membrane through which at least CO_2 gas may diffuse on top of a second membrane having pores;

passing said H_2O along said stacked membrane; and

passing said CO_2 gas along said other side of stacked membrane.

119.The method of claim 119 wherein said first membrane is Infuzor™ from Pall Corporation (Port Washington, NY).

120.The method of claim 119 wherein said CO_2 contains organic impurities.

121.The method of claim 119 wherein said organic impurities cannot pass through said first membrane into said H_2O.